

## Aerospace Forum: Rethinking Crew Error

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If the aviation industry is serious about improving safety it must recognize that crew errors are symptoms, and that the symptoms can be ameliorated only by treating the underlying causes.

Most aviation accidents are attributed to crew error, which is widely misinterpreted, sometimes even by safety experts. Too often we encounter the attitude that the crew *caused* an accident because they made errors central to the events leading up to the accident.

Accidents are usually the result of a complex convergence of events and factors. The National Transportation Safety Board often does a good job of identifying contributing factors and underlying vulnerabilities to error. However, the board's practice of naming "probable cause" is easily taken as an excuse to blame the crew.

The proclivity of some to blame the crew for inadvertent errors is an obstacle to improving aviation safety because it leads people to think the problem is lack of skill or lack of compliance by pilots.

**BUT PROBLEMS** with skill, judgment and attitudes are rare in Part 121 operations. Airline crews are highly experienced, and each airline pilot has repeatedly demonstrated high levels of skill in flight tasks. Nevertheless, even highly proficient crews make mistakes. Dr. Robert Helmreich and his research team at the University of Texas have found that airline crews on average make about two errors per flight leg and even more on challenging flights.

The true causes of accidents are rooted in the ways in which the human brain processes information; in the availability and display of information in the cockpit; in the design of equipment, charts and procedures; and in organizational attitudes and practices. For example, NASA research has demonstrated that when cockpit procedures are interrupted, especially for prolonged periods, crews

are inherently vulnerable to forgetting to complete the procedure. Interruptions are quite common, especially on busy flights.

**Conventional wisdom about pilot error is often fallacious, for example:**

Fallacy: Error can be eliminated if pilots are sufficiently vigilant and conscientious. The truth is that vigilant, conscientious pilots make mistakes, even in tasks at which they are highly skilled.

Fallacy: The crew was deficient if some aspect of their performance contributed to an accident, even if the vast majority of their performance was adequate or better. The truth is that error is probabilistic and can never be eliminated completely.

Knowing the outcome, it is easy for accident investigators to recognize that the crew chose the wrong course of action. But the crew did not know the outcome and in some cases made decisions that many other crews have made in similar circumstances.

Every day an airline crew saves the lives of their passengers by dealing calmly and competently with challenging situations. Pilots are in the cockpit because humans readily perform tasks that are far beyond the capabilities of even supercomputers. Humans have unique capability to analyze incomplete or conflicting information from diverse sources and to assess novel situations and devise appropriate solutions. This was dramatically illustrated in Sioux City, Iowa, in 1989 by Capt. Al Haynes and his United Flight 232 crew.

**BUT HERE'S THE CATCH:** The cognitive processes that enable unique human capabilities also make humans vulnerable to certain forms of error.

The good news is that error rates can be reduced by understanding how external factors interact with cognitive processing of information, by redesigning those external factors to reduce vulnerability to error and by designing systems and procedures to assist recovery from error.

Design of equipment and navigation procedures sometimes exacerbates pilots' vulnerability to these errors. For example, the lack of terminal radar and the flight management computer protocol played a role in the flight-into-terrain accident at Cali, Colombia. Organizational pressures also feed into these vulnerabilities. When ATC sets a crew up for a slam-dunk approach, the crew's awareness of the airline industry's competition for on-time performance may make them reluctant to discontinue an unstable approach.

Recognizing these issues, the Australian Transport Safety Board does not assign a "cause" in accident reports but rather lists findings and significant factors--an approach the NTSB should consider. In the absence of explicit evidence of carelessness or ineptitude, accidents should be attributed to the inherent vulnerability of expert pilots to error and to problems caused by equipment, procedures and organizations.

Crew errors and the consequences of errors can be reduced in three ways:

Design of equipment, charts and procedures should be based on the recognition that error is inevitable. Analysis of potential error paths should be part of the design process in order to reduce vulnerability and to facilitate recovery from error. The airline industry has made progress in recent years--for example, modern navigation displays help crews detect errors. However, designers need to do much more. The entire aviation system should be designed to help humans detect and correct error.

The airlines and the FAA should shift evaluation of crew performance away from counting errors and expecting performance to be error-free. Instead, the emphasis should be on detecting errors and managing the consequences of errors. We are heartened that several airlines have begun developing error management courses. In order to train error management meaningfully, airlines need hard data on the patterns of error occurring in line operations. Continental Airlines, for example, has begun systematic line audits to generate this kind of data.

Research is required for deeper understanding of cognitive vulnerability to error and to generate more powerful countermeasures. NASA and the FAA conduct research in this area, but the overall national investment is small compared to the magnitude of the problem.

But to keep aimed in the right direction, the red herring of "probable cause=crew error" should be eliminated.

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